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Foreign Investment and Productivity Growth in Czech Enterprises

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Foreign direct investment had a greater positive impact on total factor productivity in firms in the Czech Republic over a four-year period than joint ventures did, suggesting that parent firms transferred more know-how to affiliates than joint venture firms got from their partners. Firms without foreign partners experienced negative spillover effects, possibly because fewer training efforts made them less able to absorb and benefit from the diffusion of know-how.

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Summary findings

Firm-level data for the Czech Republic (1992–96) suggest that foreign investment had a positive impact on recipient firms' total factor productivity (TFP) growth. This result is robust to corrections for the sample-selection bias that prevails because foreign investment tends to go to firms with above-average productivity performance.

This result is not surprising, given the presumption that foreign investors transfer new technologies and knowledge to partner firms. With some lag, this is likely to be reflected in greater TFP growth.

Foreign direct investment appears to have a greater impact on TFP growth than joint ventures, suggesting that parent firms are transferring more know-how (soft or hard) to affiliates than joint venture firms get from their partners.

Joint ventures and foreign direct investment together appear to have a negative spillover effect on firms that do not have foreign partnerships. This effect is relatively large and statistically significant. But if the focus is restricted to the impact of foreign-owned affiliates (foreign direct investment) on all other firms in an industry, the magnitude of the negative effect becomes much smaller and loses statistical significance.

This result, together with the fact that joint ventures and foreign direct investment together account for significant shares of total output in many industries, suggests that more research is needed to determine how much knowledge diffuses from firms with strong links to foreign firms to firms that do not have such links. Especially important is the extent of spillovers among joint venture firms and between foreign affiliates and firms with joint ventures.

Insofar as joint venture firms invest more in technological capacity (as suggested by their training efforts), those firms could be expected to be better able to absorb and benefit from the diffusion of know-how. The absence of such capacity may underlie the observed negative spillover effect on other firms in the industry. Longer time series and collection of data on variables that measure firms' in-house technological effort would help identify the magnitude and determinants of technological spillovers.

This paper — a product of the Financial Economics Group — is part of a larger effort in the group to understand the transition process in the Czech Republic. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Rose Vo, room MC9-622, telephone 202-473-3722, fax 202-522-2031, Internet address hvo1@worldbank.org. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/html/dec/Publications/Workpapers/home.html. The authors may be contacted at sdjankov@worldbank.org or bhoekman@worldbank.org. May 1999. (24 pages)

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Foreign Investment and Productivity Growth in Czech Enterprises

I. Introduction

There is a rich case study literature documenting how new technologies and know-how is adopted by firms and industries. It points to the vital role of imports and openness to trade, both for learning through re-engineering and direct inputs into production, and through communications with and information from foreign partners (suppliers and buyers). Using aggregate data, a number of recent studies have concluded that trading with countries that are relatively R&D-intensive leads to higher productivity growth of domestic industry (Coe and Helpman, 1995; Coe, Helpman and Hoffmaister, 1997). While these findings are not inconsistent with the endogenous growth literature, they do not reveal much about *how* technology transfer occurs.

The micro-economic literature has emphasized three channels for the international transmission of technology: imports of new capital and differentiated intermediate goods (Feenstra, Markusen and Zeile, 1996; Grossman and Helpman, 1995); learning by exporting (Clerides, Lach and Tybout, 1998), and foreign investment (Blomstrom and Kokko, 1997). Particular attention has centered on the role of foreign investment as a channel of knowledge transfer and on the spillovers of know-how to other firms in the economy. Foreign investment should be associated with the transfer of knowledge since by definition it is driven by the existence of intangible assets owned by the parent firm (Markusen, 1995). The conventional wisdom is that foreign investment is a major channel of technology transfer to developing countries. Pack and Saggi (1997) note that intrafirm transactions in royalties and license fees between parent firms and subsidiaries account for over 80 percent of total global flows.

What matters for economic growth are the spillovers to other firms within and across industries. Evidence on this is much less robust. The case study literature has argued that positive spillovers are significant. It has also documented the importance of the availability in local skills and in-house technological capacity in adapting and using techniques developed elsewhere (Lall, 1992; Evenson and Westphal, 1995). Conversely, recent micro-econometric studies using panel datasets of enterprises have come to more ambiguous conclusions. Some analysts have found a statistically significant negative relationship between the size of foreign investment in an industry or economy and the productivity performance of domestic firms (e.g., Harrison, 1996; Haddad and Harrison, 1993).

This paper investigates the impact of foreign investment on productivity performance of firms in the Czech Republic during the initial post-reform period (1992-96).[1] We distinguish between firms that established partnerships with foreign firms—either through a joint venture or through direct sale of a majority equity stake—and those that did not, and ask whether total factor productivity (TFP) growth rates of these groups of firms differ. TFP is used as an indirect measure of technology transfer. Data constraints prohibit using more direct measures, such as R&D effort or the turnover of managers and highly skilled labor. Our results suggest that TFP growth is higher in firms with foreign partnerships, and that there is a clear hierarchy: firms that have been acquired by foreign owners have the highest TFP growth, followed by firms with joint ventures. Firms without foreign partnerships have the lowest TFP growth as a group. This result

[1] A separate but related literature on technology diffusion has focused largely on two issues: (i) analysis of the determinants of the number of firms or the proportion of industry output produced by a new technology (aggregate diffusion); and (ii) analysis of the determinants of the time at which a firm adopts a new technology relative to other firms (so-called duration models) (See e.g., Ray, 1964; Karshenas and Stoneman, 1994). Data constraints prohibit analysis of the types of questions asked in the diffusion literature as it is not possible to identify specific technologies in our data set.

continues to obtain if an adjustment is made for the higher initial level of productivity observed in firms that attract foreign participation.

We find a statistically significant negative spillover effect of foreign participation in an industry—through joint ventures and FDI—on firms without such links. This finding is consistent with the results found by Aitken and Harrison (1996) for Colombia and Haddad and Harrison (1993) for Morocco. It suggests that although foreign ownership and/or collaboration has a beneficial impact on the performance of the domestic partner entities, this has not spilled over to the rest of the industry in the time period studied. In part this result may simply reflect the fact that in a transition economy like the Czech Republic, the amount of time required to independently adapt and learn to apply more efficient techniques takes more time than is spanned by the four-year period for which we have data. The result should also be interpreted in light of the fact that on average firms with foreign partnerships account for almost 50 percent of total assets and more than 40 percent of total employment in our sample. If the analysis of spillovers is restricted to the impact of FDI (foreign majority ownership) on the rest of the industry, the spillover effect remains negative, but becomes much smaller and is no longer significant. This is likely to reflect not only the fact that joint venture firms have higher TFP growth than firms without any foreign partnerships, but may also indicate that know-how spillovers from FDI require a minimum level of technological capacity and effort to be absorbed. Survey data on training and investment in technologies suggests many domestic firms may have relatively weak capacities in this regard compared to firms with joint ventures. This illustrates the importance of taking into account differences in the characteristics of firms in each industry, in particular their

endowment of technological abilities and investments in upgrading that ability (as proxied e.g., by the level of R&D spending).

The paper is organized as follows. Section II briefly reviews the relevant literature on channels of technology transfer and spillovers. Section III describes the data set. Section IV lays out the estimation approach. Section V presents the results of the empirical analysis. Section VI concludes.

II. Channels of Technology Transfer

While there is little doubt that technologies make their way across international boundaries, the mechanisms through which this occurs are not well understood. Aside from case studies, most of the empirical evidence is based on aggregate data or cross sectional surveys, and is subject to multiple interpretations. Various transmission channels may play a role in the technology transfer process. New technologies may be embodied in goods and transferred through imports of new varieties of differentiated products or capital goods and equipment, or through arms-length trade in intellectual property, e.g., licensing contracts. Firms may learn about technologies by exporting to knowledgeable buyers, who share product designs and production techniques with them. Technology transfer will also occur in the context of formal cooperative arrangements between foreign and local firms, e.g., FDI (acquisition) or project-specific joint ventures.[2] In all these cases technology acquisition will require the availability of workers with appropriate training and expertise to allow technology absorption and adaptation. The absence of such a

[2] See e.g., Helleiner (1973) and Keesing and Lall (1992) on sub-contracting; Feenstra et al. (1992) on imports of inputs; Blomström and Kokko (1997) for a recent survey of the literature on FDI; and Pack and Saggi (1997) for a general survey of the literature on technology transfer.

capacity is often held to explain why TFP is frequently lower in developing countries firms than in industrialized nations even if identical equipment is utilized (Pack, 1987).

It is helpful to differentiate between technology transfers that are realized in the context of formal cooperative arrangements between a foreign and a domestic firm and those that occur at "arms-length." The latter, which include arms-length trade in machinery and components and direct purchases of knowledge (payment for patents, blueprints, etc.) can be a major avenue of technology transfer. However, not all technologies are available at arms-length. Many may only be obtainable through formal cooperation--either majority ownership (acquisition) or project-specific joint ventures.[3] In theory, firms will be adverse to unbundling and selling know-how or products if there are important internalization incentives—FDI may then be the preferred route to exploit knowledge advantages (Markusen, 1995; 1998).

Foreign investment is likely to be associated with transfer of both hard (machinery, blueprints) and soft (management, information) technologies. It will have two dimensions: "generic" know-how such as management skills, quality systems, etc.; and specific know-how that cannot be obtained at arms-length because of weaknesses in the existing policy environment (e.g., enforcement of intellectual property rights)[4] or because of internalization incentives. As regards the former, foreign partners may reduce the cost of upgrading and learning by assisting in the identification and implementation of systems to ensure that production meets technical specifications, is delivered on time, etc. Interviews with managers of enterprises with foreign

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[3] Notions of arms-length exchange used in the literature vary. For example, Pack and Saggi (1997) make a distinction between intrafirm exchange (FDI) and contractual exchanges (licensing, joint ventures, turn key projects, etc.). They call the latter arms-length arrangements.

[4] See Smarzynska (1998) for a recent analysis of the relationship between intellectual property protection and FDI in transition economies.

partnerships by the authors suggest that all of these dimensions are prevalent in the Czech Republic. But more important is presumably the access to unique parent-firm-specific information, as well as production and distribution networks.

A question is whether and to what extent the knowledge "transferred" by multinationals to affiliates diffuses to other firms in the industry.[5] Theoretical models of foreign investment suggest there should be a positive relationship between FDI and diffusion. Know-how will diffuse from firm to firm through demonstration effects, labor turnover, or reverse engineering. Das (1987) models a foreign subsidiary as a price leader, and domestic firms as a competitive fringe. If learning by domestic firms is proportional to the output of the multinational firm—i.e., the larger the multinational is relative to the domestic industry, the easier the learning—this creates incentives to transfer technology to its subsidiary as profits are higher if more advanced technology is used. The greater output of the subsidiary then induces native firms learn and adopt the foreign technology at a higher rate. Wang and Blomström (1992) use a similar setup, but endogenize both the level of technology transfer from the parent company to the subsidiary and the investment in learning activities by the domestic firm. Foreign firms again transfer technology at a higher rate if domestic firms invest more in the learning activities. Some empirical support for this prediction is found by Blomström, Kokko and Zejan (1994).

The empirical evidence on spillovers from foreign-owned affiliates to indigenous firms is mixed (Blomström and Kokko, 1997). There is an extensive case study literature that seeks to determine whether and how large spillovers from R&D are. Much of this focuses on

[5] Equally important may be spillovers across industries. This is an issue that is not explored in this paper, although it may be important in the transition context.

industrialized countries.[6] The literature on developing countries has documented that the magnitude of potential knowledge spillovers depends importantly on the existence of technological capabilities allowing the assimilation of know-how by indigenous firms (Pack and Westphal, 1995). A unique feature of many transition economies in comparison to most developing countries is that technological ability is substantially greater. In principle, this should facilitate adoption of new technologies and allow rapid convergence towards "best practice."

Much of the econometric literature has focused on productivity measures as a proxy measure of technology diffusion. Early studies such as Blomström and Persson (1983), using industry level data, found that domestic labor productivity is positively influenced by foreign presence in an industry, measured by the foreign share of industry employment. More recent studies using firm level data are less supportive of the existence of spillovers. Aitken and Harrison (1997) and Haddad and Harrison (1993) find that foreign investment has a negative effect on the performance of domestically owned firms. Harrison (1996) suggests that in imperfectly competitive markets entry by foreign investors implies that domestic incumbents lose market share and this impedes their ability to attain scale economies. The negative spillover results contrast with the findings of the case study-based literature and may to some extent reflect the omission of important variables such as the level of R&D spending, expenditures on training and the magnitude of employment of personnel with technical degrees (engineers, scientists).[7]

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[6] See Griliches (1992) for a survey of the literature on R&D spillovers, Nelson and Wolff (1997) for a recent contribution to this literature.

[7] The literature on technology acquisition and adoption in developing countries is substantial. See, for example, Evenson and Westphal (1987), Lall (1987; 1992), and Pack and Westphal (1986). Westphal, Rhee and Pursell (1981) discuss the case of Korea in some depth..

The analysis in this paper relies on the estimation of production functions and the use of TFP as a proxy measure for technology transfer. Our reliance on TFP as the dependent variable assumes that the adoption of new technologies will, with some lag, lead to an improvement in productivity. A serious problem with this assumption is that the case study literature has documented that such productivity improvements are dependent on the technological abilities of domestic firms. Nelson and Pack (1998) have demonstrated that the production function methodology can underestimate or ignore the role of technological effort at the level of the firm, and thus affect TFP growth estimates. Differences in technological capacity across firms in an industry may be an important determinant of TFP performance, but we do not have information on this at the level of the firm—data on technology-relevant variables such as R&D expenditure or the composition of the workforce are not available at the level of the firm. However, the Czech Republic is not a developing country—it has a long-standing industrial base and is well-endowed with engineering and scientific human capital. For the economy as whole, therefore, the capacity to rapidly upgrade productive efficiency through the adoption of best practice techniques (both hard and soft) should be considerable. Note that this makes the Czech case less relevant as a comparator for developing countries that do not have equivalent endowments.

III. Profile of Czech Firms

Information on Czech enterprises was compiled for the 1992-97 period from surveys using a questionnaire prepared by the authors and a database containing financial and ownership information. Financial variables were defined using international accounting standards from the onset of the survey in 1992. The database comprises 513 firms quoted on the Prague stock

exchange whose shares traded at least four times in a given year and report the financial information required. Of the sample firms, 340 did not establish joint ventures or attract FDI; 91 concluded joint ventures with foreign companies and 82 attracted majority foreign equity investment. Thus, 34 percent of the sample (173 firms) had a foreign link—either a joint venture or FDI, with relatively uniform distribution across sectors (Table 1).

Table 1: Descriptive Statistics of the Sample

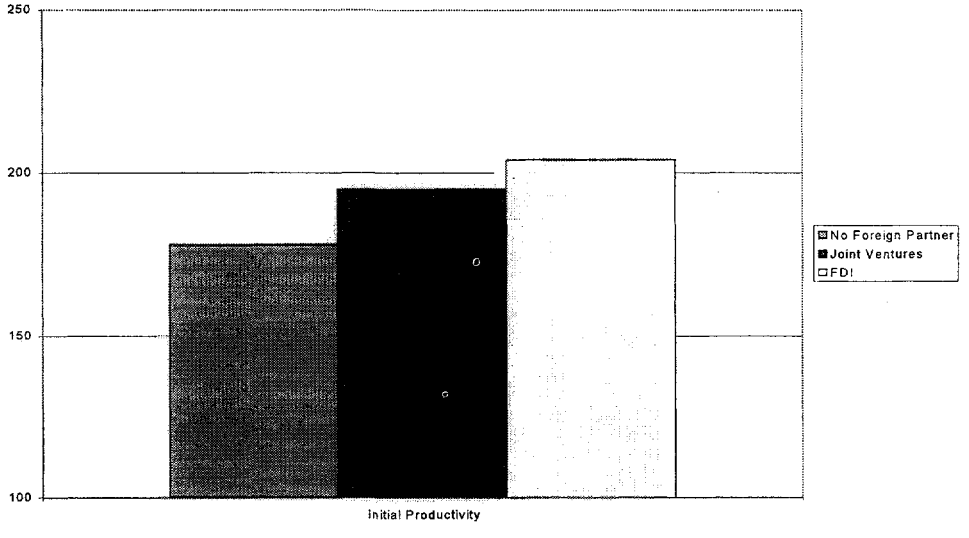
Sector	Total Sample	No Foreign Partner	Foreign Partner (FDI or J.V.)
Mining	11	8	3
Construction	82	55	27
Food and beverage	54	36	18
Textiles and Apparel	39	28	11
Furniture and Other Wood Products	11	5	6
Pulp and paper	14	10	4
Printing and Publishing	13	6	7
Chemicals	30	18	12
Shoes and Leather Products	6	5	1
Non-Metallic Mineral Products	21	16	5
Basic Metals	13	9	4
Fabricated Metal Products	24	12	12
Electric and Electronics	82	54	28
Transport Equipment	12	5	7
Other Manufacturing	10	6	4
Retail Services	15	11	4
Financial services	76	56	20
Number of Observations	513	340	173
Share in Total	100.0%	66.3%	33.7%

The criterion used in our sample to determine the existence of a foreign partnership or ownership relationship is that at least 20 percent of the equity is owned by a single foreign entity or that the firm has established one or more joint ventures with a foreign partner. Because minority shareholders have little protection under Czech law, equity investors have an incentive to take a majority stake. Most firms with foreign equity ownership in the sample are majority foreign owned. While the share of firms with foreign linkages appears to be high, it is representative of Czech industry more generally. Aggregate statistics using a 5 percent or more

foreign equity ownership share as a criterion reveal that during 1994-97, 42 percent of all manufacturing firms with more than 10 employees were involved in some kind of foreign partnership (Czech Statistical Office, 1998).

Firms with foreign partnerships tend to be significantly larger than firms that remain independent: the median level of total employment in FDI firms is 689, in firms with joint ventures the median number of employees is 578, as compared to 352 employees in the median firm without foreign links. Foreign affiliates or joint ventures also have higher levels of initial labor productivity, measured as sales per worker in 1991 (Figure 1). This suggests that foreign investors are attracted to firms with above average performance and size.

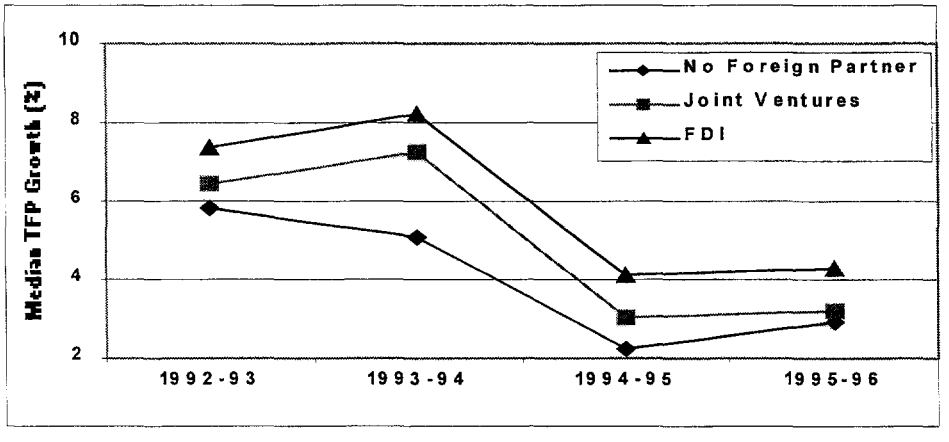
Figure 1: Labor Productivity, 1991 (in 1,000 CK)



Average TFP growth performance of firms with FDI is also highest of the three groups, followed by firms with joint ventures and domestic enterprises (Figure 2). This may be a reflection of the better than average initial level of productivity performance, suggesting foreign investors choose the "best" firms as partners. In the statistical analysis we therefore correct for

the possibility of selection bias. The magnitude of TFP growth rates is highest in earlier years and tapers off towards the end of the sample period. This reflects a marked deterioration in macroeconomic conditions in 1996, a common effect for all firms. TFP growth rates initially diverge substantially, with firms with foreign investment increasing growth, while other firms experience a reduction in TFP growth rates. Thereafter some convergence occurs, suggesting that there may be spillover effects occurring towards the end of the period.

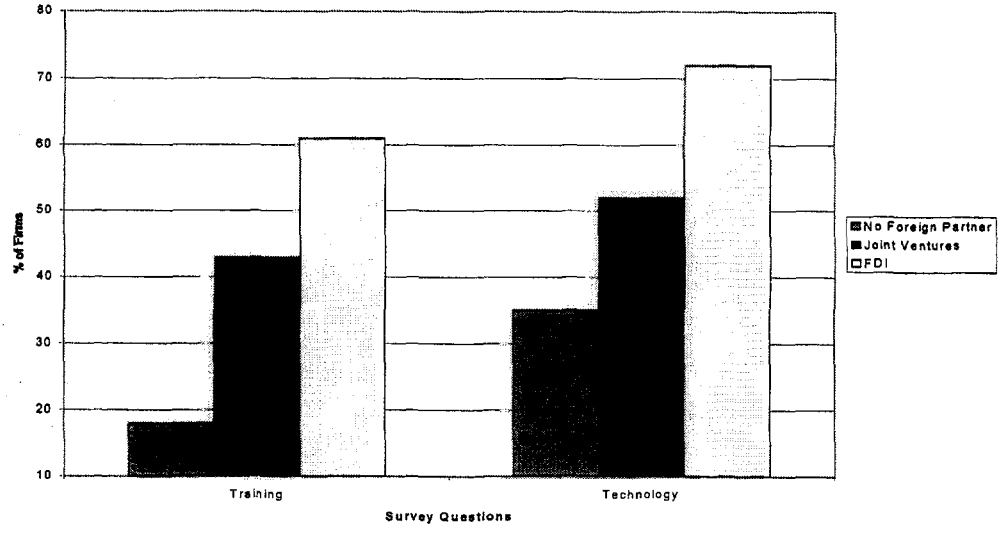
Figure 2: Total Factor Productivity Growth



Questionnaires suggest that both joint ventures and FDI are associated with technology transfers. Figure 3 presents the results of a questionnaire sent to the firms in the sample in early 1997. Two questions related to training and acquisition of new technologies were included. Managerial responses clearly reveal what appears to be a significant difference between firms with and without foreign partnerships. The first question asked managers "Have your workers undergone any training in the last two years?". Managers were given discrete choices "Yes/No." In firms without foreign partners only 18 percent replied in the affirmative, while 47 and 60 percent of managers whose firms were involved in either joint ventures or FDI, respectively,

answered positively. The second question asked whether new technology (machinery, equipment) or related know-how had been obtained in the previous two years. Foreign investment was again associated with substantially greater positive responses—in over 70 percent of the FDI cases and 50 percent of the joint ventures, the partner acquired some kind of new technology, as opposed to 35 percent for firms without foreign linkages. Note that the relative difference between the two sets of firms on the training variable ("software") is greater than on the technology ("hardware") variable. These figures illustrate that although we do not have firm-level data on technological effort, foreign partnerships are associated with greater investments in training and knowledge acquisition.

Figure 3: Training and New Technology



IV. Estimation Procedure

We estimate production functions for the firms included in the sample. Each firm *i* has a production function for gross output:

(1) $$Y_i = F^i(L_i, M_i, K_i, T_i)$$,

where Y is gross output, K, L and M are inputs of capital, labor, and materials, and T indexes technology. The firm's production function F is homogeneous of degree g $(g \neq 1)$ in K, L, and M. Firms are assumed to be price takers on factor markets, but may have market power in output markets. The former assumption is reasonable since wages were largely set centrally during the sample period, and most materials were bought abroad at world-market prices.

The production function in (1) implies the following relation between marginal physical products and outputs:[8]

$$F_L^i \, \mathrm{L_i} + F_M^i \, \mathrm{M_i} + F_K^i \, \mathrm{K_i} = \mathrm{g}_i Y_i \tag{2}$$

where F_J^i is the marginal product of input J. The optimal choice of inputs by a firm with some monopoly power implies:

$$P_i F_J^i = \mu_i P_{Ji} \tag{3}$$

where P_{Ji} is the price of factor J, P_i is the price of the firm's output, and μ_i is the markup of price over marginal cost: $\mu_i = P_i / MC_i$, where MC_i is marginal cost. Combining (2) and (3) we obtain

$$s_{Li} + \mathrm{s_{Mi}} + \mathrm{s_{Ki}} = \mathrm{g}_i / \mu_i \tag{4}$$

where $\mathrm{s_{Ji}} = P_{ji} \, J_i \, / \, P_i \, Y_i$ are the expenditures on each factor J_i relative to total enterprise revenues. Since firms do not necessarily produce under constant returns to scale, the sum of these shares is not always unity. The revenue share of capital can be defined as:

$$\hat{s}_{Ki} = 1 - \mathrm{s_{Li}} - s_{Mi} = \mathrm{s_{Ki}} + (1 - \mathrm{g}_i / \mu_i), \text{ (using equation 4).} \tag{5}$$

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[8] We are grateful to a referee for suggesting the specific formulation used below.

The productivity equation can then be derived from equations (1) as

$$(6) \qquad dy_i = \mu_i\left[s_{Li}dl_i + \hat{s}_{Ki}dk_i + s_{Mi}dm_i\right] + \mu_i\left[s_{Ki} - \hat{s}_{Ki}\right]\mathrm{dk}_i + \frac{F_T^i T_i}{F^i}dt_i$$

where dy_i is output growth and $\frac{F_T^i T_i}{F^i}dt_i$ measures the technology change or TFP growth. The second term on the right hand side can be simplified to $(g_i - \mu_i)dk_i$ using (5). Equation (6) is estimated in log-differences, using actual enterprise-level data to construct the first right-hand side term. There are two terms to estimate for each industry (g_i and μ_i, the scale and markup parameters), as well as the TFP parameter for each enterprise. We use the reported book value of fixed assets to construct the capital revenue share.

To take into account the likelihood that foreign investment choices are not randomly distributed—the descriptive statistics reported in Table 1 suggest that the firms attracting FDI and joint ventures have above average initial performance—we correct for the possible endogeneity of foreign investment choices by using the generalized Heckman two-step procedure for correcting sample selection bias as developed by Amemiya (1984). This involves separate estimation of the foreign investment decision and the subsequent firm productivity growth performance. The first step uses a probit model to determine the probability of foreign investment based on initial efficiency (proxied by the share of variable costs in total revenues), firm size, and type of industry. The second step involves an estimation, using only observations on firms with foreign linkages. This results in an omitted variable sample selection bias. The Amemiya procedure provides for a specification of the omitted variable that can be used in the full sample to alleviate sample selection. An additional variable estimated in the first step is included in the second-step regression.

Since the primary focus of this paper is to test the association between productivity growth and foreign investment, we augment equation (6) by including a dummy for firms with foreign partners as an additional "factor of production." The dummy (FOREIGN) is 1 if a firm had a either FDI or a joint venture in the preceding year, 0 otherwise. This approach is similar to the empirical design used in Harrison (1994). In addition, the effects of other changes in the economic environment have to be controlled for. We do not have good proxies for these changes, nor can we account individually for each of them. Instead, we include annual dummies in the estimating equation which pick up the net effects of changes in the economic environment at the aggregate level.

We are also interested in investigating whether there have been any spillover effects from foreign investment on other firms which operate in the same sectors but do not have foreign partners. To analyze this, we run equation (6) on local firms only, and include as an additional independent variable (SPILLOVER) the share of assets of firms with FDI or joint ventures in total assets of all firms in each sector. If foreign participation has beneficial spillover effects on other firms, we would expect the coefficient to be positive.

Because of the probable correlation between productivity effects and the independent variables, ordinary least squares (OLS) may give biased and inconsistent estimates. This simultaneity problem is endemic to the empirical literature on productivity measurement. We address the issue by using F-tests to reveal whether OLS is appropriate, and relying on the Hausman specification test to choose between random or fixed effects frameworks in cases where OLS should not be used. These tests suggest that a random effects model is most

appropriate.[9] Coefficient estimates for the major coefficients or variables of interest are reported in Table 2, as well as information on the share of assets of firms with either joint ventures of FDI in total assets (48%) and the share of firms with majority foreign ownership (19%).

Table 2: Revenue Shares of Inputs, Mark-up and Scale Estimates

Sector	S_m	S_l	S_k	μ_i	g_i	Share of Foreign Assets	Share of FDI Assets
Mining	0.538	0.215	0.246	1.246	1.200	0.398	0.124
Construction	0.720	0.169	0.111	1.137	1.088	0.432	0.325
Food and beverage	0.629	0.206	0.165	1.388	1.264	0.635	0.311
Textiles and Apparel	0.677	0.180	0.142	1.284	1.132	0.294	0.182
Furniture and Other Wood Products	0.743	0.145	0.110	1.152	1.001	0.542	0.261
Pulp and paper	0.791	0.129	0.079	1.211	1.113	0.715	0.521
Printing and Publishing	0.730	0.136	0.133	0.889	0.992	0.885	0.605
Chemicals	0.757	0.151	0.091	1.201	1.163	0.547	0.281
Shoes and Leather Products	0.612	0.224	0.162	1.182	1.119	0.128	0.000
Non-Metallic Mineral Products	0.615	0.191	0.193	0.958	0.996	0.408	0.241
Basic Metals	0.702	0.155	0.142	1.211	0.880	0.367	0.134
Fabricated Metal Products	0.733	0.121	0.145	1.192	1.100	0.785	0.191
Electric and Electronics	0.657	0.191	0.151	1.201	1.039	0.356	0.110
Transport Equipment	0.687	0.117	0.195	1.272	1.070	0.428	0.127
Other Manufacturing	0.594	0.171	0.233	n.a.	n.a.	0.524	0.229
Retail Services	0.257	0.453	0.289	1.352	1.198	0.402	0.221
Financial Services	0.190	0.609	0.200	1.079	1.324	0.368	0.141
Average	0.625	0.209	0.164	1.184	1.104	0.483	0.191

V. Results

The results of estimating equation 6 are reported in Table 3, using both OLS and a random effects specification. The estimated coefficient on the dummy for FDI is positive and statistically significant for both specifications. This suggests that as predicted foreign investment involves an additional "transfer of technology". The dummy for joint ventures also has a positive sign, but is slightly smaller in magnitude and is not statistically significant.

[9] A fixed- effects estimation assumes firm productivity growth to be constant over time. This assumption is objectionable since changes in productivity due to increased competition is the phenomenon we seek to explore. The random-effects model avoids the imposition of constant productivity growth over time, but has the drawback that productivity shocks at the firm level are assumed to be uncorrelated over time. This may not be a reasonable restriction if there is convergence or divergence in corporate performance.

Table 3: Panel Regression Estimates (Full Sample)

Dependent variable: Growth in Sales	OLS	Random-Effects
Amemiya Selection Bias Correction Variable	Yes	Yes
Sector-Specific Returns to Scale and Mark-ups	Yes	Yes
FDI Dummy	0.015**	0.015*
	(2.011)	(1.937)
JV Dummy	0.011	0.010
	(1.372)	(1.286)
Dummy for 1994	-0.012*	-0.011
	(-1.873)	(-1.672)
Dummy for 1995	-0.052**	-0.052**
	(-7.034)	(-6.942)
Dummy for 1996	-0.054**	-0.053**
	(-7.062)	(-7.534)
No. of observations	513	513
F-test (A, B = A_i, B)	0.89	
Hausman test (random vs. fixed effects)[a]		25.66 (30.19)
Adjusted R^2	0.894	0.861

Notes: Heteroskedasticity consistent (White correction); t-statistics in parentheses; a constant term is included in both regressions. [a] Cut-off point in parentheses;
* Significant at the 90% level; ** Significant at the 95% level.

The possibility of a positive spillover impact of foreign investment is considered by including the share in total assets of firms with foreign partners (lagged one year) as a separate regressor. This is a continuous, not a categorical variable. As noted previously, this approach assumes that spillovers are sector-specific, and therefore ignores possible inter-industry spillovers. Table 4 reports the results of considering both joint ventures and FDI, i.e., foreign investment broadly defined. Contrary to what is predicted, spillovers are negative: greater foreign participation in an industry has a statistically significant negative effect on the performance of other firms. Each 10 percent increase in the foreign asset share is associated with a 1.7 percent fall in sales growth of domestic firms.

Table 4: Spillover Effects (Firms Without Foreign Linkages)

Dependent variable: Growth in Sales	OLS	Random-Effects
Amemiya Selection Bias Correction Variable	Yes	Yes
Sector-Specific Returns to Scale and Mark-ups	Yes	Yes
Spillovers (Share of assets of firms with joint ventures and FDI)	-0.178** (3.125)	-0.172** (2.054)
Dummy for 1994	0.002 (0.215)	0.002 (0.178)
Dummy for 1995	-0.038** (-4.201)	-0.037** (-3.934)
Dummy for 1996	-0.036** (-3.534)	-0.035** (-3.642)
Observations	340	340
F-test	0.92	
Hausman test (random vs. fixed effects)		4.57 (14.45)
Adjusted R2	0.887	0.843

Notes: Heteroskedasticity consistent (White correction); t-statistics in parentheses; a constant term is included in both regressions; ** Significant at the 95% level.

It has been argued that spillovers from joint ventures should be higher than those from FDI (establishment of majority-owned affiliates) as the foreign partner has less ability to control the behavior of the domestic partner, and the latter has a greater incentive to pursue R&D itself (see, e.g., Pack and Saggi, 1997). Internalization through FDI in contrast should offer greater opportunities to limit "technology leakage." If this is indeed the case, it implies that excluding joint ventures from the SPILLOVER measure of foreign "ownership" share and re-estimating the equation should increase the magnitude of the negative spillovers. The evidence, however, does not support this argument (Table 5). Instead, the magnitude of the spillover effect becomes smaller and statistically insignificant, although it remains negative in sign (Table 6). Thus, excluding joint ventures has an offsetting effect. In part this reflects the fact that joint venture firms have higher TFP growth than firms without any foreign partnerships, and this raises the average of the non-FDI group. This result illustrates that the initial negative spillover result may not be robust and that tests for spillovers with the methodology used here (and in the literature

more generally) require some assurance that in distinguishing between two subsets of firms in an industry on the basis of whether or not there is majority foreign ownership (or more generally foreign linkages of some kind) one is not ignoring other important determinants of the performance of firms.

Table 5: Testing for Spillover Effects
(Firms without FDI)

Dependent variable: Growth in Sales	OLS	Random-Effects
Amemiya Selection Bias Correction Variable	Yes	Yes
Sector-Specific Returns to Scale and Mark-ups	Yes	Yes
Spillovers (Share of assets of foreign affiliates in total assets of the sector)	-0.077 (1.425)	-0.074 (1.218)
Dummy for 1994	0.003 (0.897)	0.002 (0.178)
Dummy for 1995	-0.032** (-2.985)	-0.031** (-2.257)
Dummy for 1996	-0.027* (-1.847)	-0.025 (-1.514)
Observations	431	431
F-test	0.91	
Hausman test (random vs. fixed effects) a		4.13 (14.45)
Adjusted R2	0.894	0.857

Notes: Heteroskedasticity consistent (White correction); t-statistics in parentheses; a constant term is included in both regressions; a: Cut-off point in parentheses; * Significant at the 90% level; ** significant at 95% level.

One such determinant likely to be important is the technological effort of firms. The survey questionnaire revealed that joint venture firms invested significantly more in training and new technologies than pure "domestic" firms. It may be that the technological ability and effort expended by many of the firms without foreign partners is too low to be able to absorb spillovers when they occur, or that the firms with foreign linkages have absorbed a significant share of the available stock of labor with requisite skills. Also, given that FDI and joint ventures together account for significant shares of total assets, sales and employment in the Czech Republic, the potential for positive spillovers among firms with foreign partnerships, e.g. from FDI firms to

joint ventures, and among joint ventures, may be significant. It is suggestive that if "domestic" firms are excluded from the sample, FDI has a positive effect on firms with joint ventures, although this is not statistically significant (the t-statistic is 1.42, possibly reflecting the small sample size).

Finally, account should also be taken of the short time frame on which the study has focused. Spillovers may require more time before they show up in TFP growth rates. And, as mentioned earlier, the absorption of new techniques requires significant in-house technological effort which may not be captured adequately by the production function methodology used. Clearly further research is required.

VI. Concluding Remarks

Firm-level data for the Czech Republic during 1992-96 suggest that foreign investment has the predicted positive impact on the TFP growth of recipient firms. This result is robust to corrections for the sample selection bias that prevails because foreign investment tends to go to firms with above average initial productivity performance. This result is not surprising, given that there is a presumption that foreign investors should be transferring new technologies and knowledge to partner firms. With some lag, this is likely to be reflected in greater TFP growth. FDI appears to have a greater impact on TFP growth than joint ventures, suggesting that parent firms are transferring more know-how (soft or hard) to affiliates than joint venture firms obtain from their partners.

Taken together, joint ventures and FDI appear to have a negative spillover effect on firms in each industry that do not have foreign partnerships. This effect is relatively large and statistically significant. However, if the focus of attention is restricted to the impact of foreign-

owned affiliates (FDI) on all other firms in an industry, the magnitude of the negative effect becomes much smaller and loses statistical significance. This result, in conjunction with the fact that taken together joint ventures and FDI account for significant shares of total output in many industries, suggests that further research is required to determine the extent to which knowledge diffuses from firms with strong linkages to foreign firms to those that do not have such relationships. Of particular importance in this connection is to explore the extent of spillovers among joint venture firms and between foreign affiliates and firms with joint ventures. Insofar as joint venture firms invest more in technology capacity (as suggested by their training efforts), one expects these firms to be better able to absorb and benefit from know-how diffusion. The absence of such capacity may be a factor underlying the observed negative spillover effect. Longer times series and collection of data on variables that measure in-house technological effort by firms would help to identify the magnitude and determinants of technological spillovers.

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